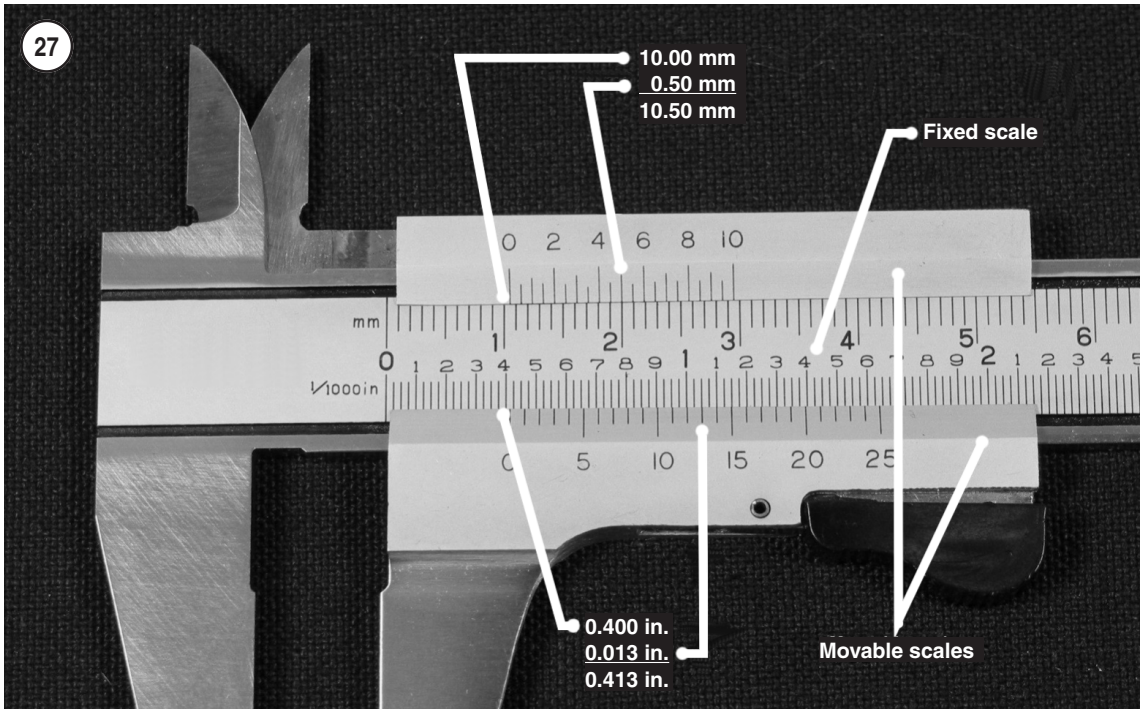

hammer for the job and make sure to strike the object squarely. Do not use the handle or the side of the hammer to strike an object.

PRECISION MEASURING TOOLS

The ability to accurately measure components is essential to successful service and repair. Equipment is manufactured to close tolerances, and obtaining consistently accurate measurements is essential to determining which components require replacement or further service.

Each type of measuring instrument (**Figure 25**) is designed to measure a dimension with a particular degree of accuracy and within a certain range. When selecting a measuring tool, make sure it is applicable to the task.

As with all tools, measuring tools provide the best results if they are cared for properly. Improper use can damage the tool and result in inaccurate results. If any measurement is questionable, verify the measurement using another tool. A standard gauge is usually provided with measuring tools to check accuracy and calibrate the tool if necessary.

Precision measurements can vary according to the experience of the person taking the measurement. Accurate results are only possible if the mechanic possesses a feel for using the tool. Heavy-handed use of measuring tools produces less accurate results than if the tool is handled properly. Grasp precision measuring tools gently between fingertips so the point at which the tool contacts the object is easily felt. This feel for the equipment produces consistently accurate measurements and reduces the risk of damaging the tool or component. Refer to the following sections for a description of various measuring tools.

Feeler Gauge

The feeler or thickness gauge (**Figure 26**) is used for measuring the distance between two surfaces.

A feeler gauge set consists of an assortment of steel strips of graduated thicknesses. Each blade is marked with its thickness. Blades can be of various lengths and angles for different procedures.

A common use for a feeler gauge is to measure piston ring end gap. Wire (round) type gauges are used to measure spark plug gap.

Calipers

Calipers (**Figure 27**) are excellent tools for obtaining inside, outside and depth measurements. Al-

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DECIMAL PLACE VALUES*

0.1	Indicates 1/10 (one tenth of an inch or millimeter)
0.010	Indicates 1/100 (one one-hundreth of an inch or millimeter)
0.001	Indicates 1/1,000 (one one-thousandth of an inch or millimeter)

*This chart represents the values of figures placed to the right of the decimal point. Use it when reading decimals from one-tenth to one one-thousandth of an inch or millimeter. It is not a conversion chart (for example: 0.001 in. is not equal to 0.001 mm).

though not as precise as a micrometer, they allow reasonable precision, typically to within 0.05 mm (0.001 in.). Most calipers have a range up to 150 mm (6 in.).

Calipers are available in dial, vernier or digital versions. Dial calipers have a dial readout that is convenient to read. Vernier calipers have marked scales that must be compared to determine the measurement. The digital caliper uses an LCD display to show the measurement.

Properly maintain the measuring surfaces of the caliper. There must not be any dirt or burrs between the tool and the object being measured. Never force the caliper closed around an object. Close the caliper around the highest point so it can be removed with a slight drag. Some calipers require calibration. Always refer to the manufacturer's instructions when using a new or unfamiliar caliper.

Figure 27 shows a measurement taken with a vernier caliper. Refer to the metric scale and note that the fixed scale is graduated in centimeters, which is indicated by the whole numbers 1, 2, 3 and so on. Each centimeter is then divided into millimeters, which are indicated by the small line between the whole numbers (1 centimeter equals 10 millimeters). The movable scale is marked in increments of 0.05 (hundredths) mm. The value of a measurement equals the reading on the fixed scale plus the reading on the movable scale.

To determine the reading on the fixed scale, look for the line on the fixed scale immediately to the left of the 0-line on the movable scale. In **Figure 27**, the fixed scale reading is 1 centimeter (or 10 millimeters).

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To determine the reading on the movable scale, note the one line on the movable scale that precisely aligns with a line on the fixed scale. Look closely. A number of lines will seem close, but only one lines up precisely with a line on the fixed scale. In **Figure 27**, the movable scale reading is 0.50 mm.

To calculate the measurement, add the fixed scale reading (10 mm) to the movable scale reading (0.50 mm) for a value of 10.50 mm.

Micrometers

A micrometer is an instrument designed for linear measurement using the decimal divisions of the inch or meter (**Figure 28**). While there are many types and styles of micrometers, most of the procedures in this manual call for an outside micrometer. The outside micrometer is used to measure the outside diameter of cylindrical forms and the thickness of materials.

A micrometer's size indicates the minimum and maximum size of a part that it can measure. The